TITLE: A Modern Integrated Avionics System for the Next Generation U.S.M.C. Attack and Utility Helicopters

A MODERN INTEGRATED AVIONICS SYSTEM FOR THE NEXT GENERATION U.S.M.C. ATTACK AND UTILITY HELICOPTERS

SUMMARY

The United States Marine Corps awarded the first phase of the H-1 platform upgrade program to Bell Helicopter in late 1996. This effort resulted in substantial improvements to both the AH-1 Gunship and UH-1 Utility aircraft. Upgrades included a new transmission and a 4-bladed rotor with resulting improvements in mission effectiveness and cost of ownership. In 1997, the program was expanded to provide a modern suite of avionics incorporating improved sensors, cockpits, weapons processing, helmet-mounted displays and an advanced centralized mission processing subsystem. This technical paper will review the basis for architectural decisions of the avionics and the criteria for selection of key sensors and displays. Major attributes of redundancy and commonality are described, together with an overview of an advanced open architecture mission computer.

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INTRODUCTION

The H-1 Integrated Avionics System (IAS) responsibility was given to Litton Guidance & Control Systems in August of 1997 as an extension to major ongoing upgrades to AH-1 and UH-1 airframes. The contract requires delivery of cockpit displays and controls, helmet display subsystem, communications, navigation, wing stores weapons management system, turreted 20 mm gun control, and a central mission computing subsystem. Since then, Lockheed Martin Corporation has been selected to provide a long-range Target Sighting System consisting of a third generation FLIR, color TV, and laser subsystem, complementing the Hellfire missile used in the AH-1.

Airframe improvements include a new 4-bladed composite rigid rotor and drive system, new tail rotor, increased horsepower, accommodation of increased crash loads, improved payload accommodations within the UH-1, added weapons stores station on the AH-1, and an increase in fuel capacity. These improvements, together with the new avionics, will deliver the most affordable and technically advanced helicopters geared for the new mission roles anticipated over the next 25 years. Figure 1 illustrates the scope of these upgrades as they apply to the AH-1, now called the AH-1Z, with similar scope of improvements to the UH-1Y. In total, these new configurations benefit from 55 percent commonality by weight, 60 percent by costs, and 85 percent for significant maintenance items, and result in substantial increases to payload, range, and affordability.

This upgrade was preceded by a series of studies to determine the most cost-effective way of optimizing helicopter warfighting capability for the diverse mission roles of the U.S. Marine Corps. Enhancements to both platforms resulted in:

- Improved mission capability
- Increased performance and maneuverability
- Additional features for survivability
- Reduced pilot workload
- Increased growth potential

Recognition that these platform types will be accepted into service in a new generation of threat has shaped the decisions both for the basic platforms and avionics.

Warfighting requirements and the identification of those technologies needed to support them are derived from the U.S. DoD analysis and directives contained within Joint Vision 2010. In some regards, this listing of about one dozen supporting objectives have all influenced the AH-1Z and UH-1Y products, but primarily the avionics upgrade is linked to:

- Information superiority
- Application of precision force
- Improved combat identification
- Military operations in urban terrain
- Improved capability for Electronic Warfare (EW)

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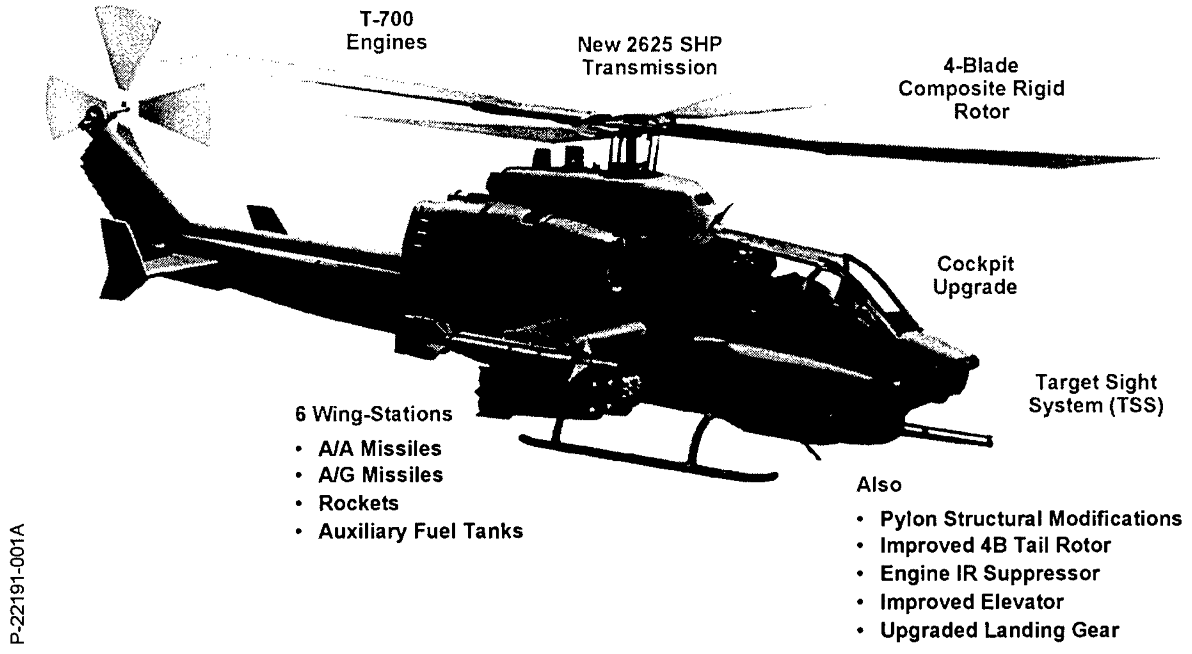


Figure 1. Scope of Upgrades

Diversity of the U.S. Marine Corps charter demands more mission versatility than the specialized helicopter gunship solutions of the past decade, and illustrates a profound shift from the linear battlefield expectation considered in the older culture of designs, to a theatre of operations addressing deployment in a Network Centric setting; autonomous or detached authority; and low intensity conflicts seeking targets of opportunity.

It is appropriate to consider further, the demands of Joint Vision 2010 and recognize that attainment of information superiority is achieved with excesses of "bandwidth, storage, and processing." This is the means to achieve capability in the Network Centric Warfare setting: a situation in which diverse resources of land, sea, and air will exchange complex information to execute time critical missions. These data types are expected to include broadcasted maps, video mosaics, retargeting directives, and a variety of large database retrievals. This has been the basis for development of a modern general purpose Mission Computer, delivering enormous built-in growth, with upgrade paths linked to this future technology base. It also has been pivotal in the decision to select a centralized architecture of processing, video/graphics, communications data linking, and opportunities for large database access. Shown in Figure 2 is this approach concept which links complex onboard information with realtime data updates into aviator useable format.

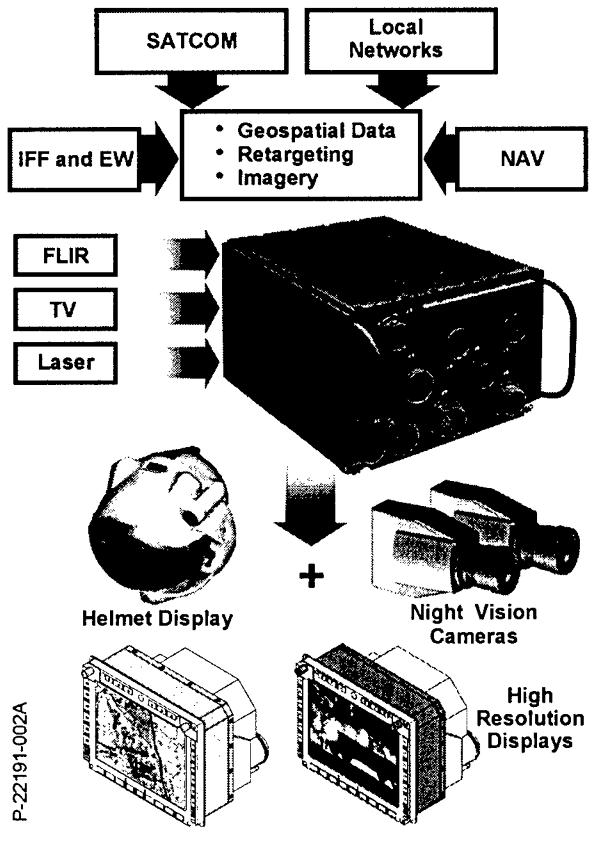


Figure 2. Centralized Processing of Data, Graphics, and Video to Support Information Fusion

COMBAT VISION – "THE GUNSHIP NEED FOR SITUATIONAL AWARENESS"

The supporting objectives identified in Joint Vision 2010 and the added needs in a U.S. Marine Corps mission are best realized by improvements to situational awareness. It is here that the technologies and mission execution effectiveness optimally merge. Specifically, it is necessary to give the aviator capabilities for:

- Execution of time critical missions
- A consistent understanding of the battlespace
- Accommodation within a communication grid of assured services
- Assured combat identification

This avionics upgrade delivers the most modern combination of sensors, displays, and information gathered to meet these needs, as depicted in Figure 3. This is a solution satisfying demands for advanced tactical communications, improved electro-optical/ infrared imaging, inherent bandwidth and throughput, and of course, crew interfaces including high resolution color MFDs, and a full-function helmet-mounted display.

Helmet-Mounted Display

The advantages of a helmet-mounted display in a helicopter gunship are well recognized. However, a full functional capability which provides total symbology needs in an unambiguous see-through visor has heretofore not been achieved. The challenges are substantial, but the value to the aviator and the mission are profound. Developed as part of the Integrated Avionics System (IAS), this subsystem satisfies all the needs for basic aviator safety, optical performance in full daylight mode,and most impressively, has exceeded the night pilotage specifications using clip-on image intensified cameras.

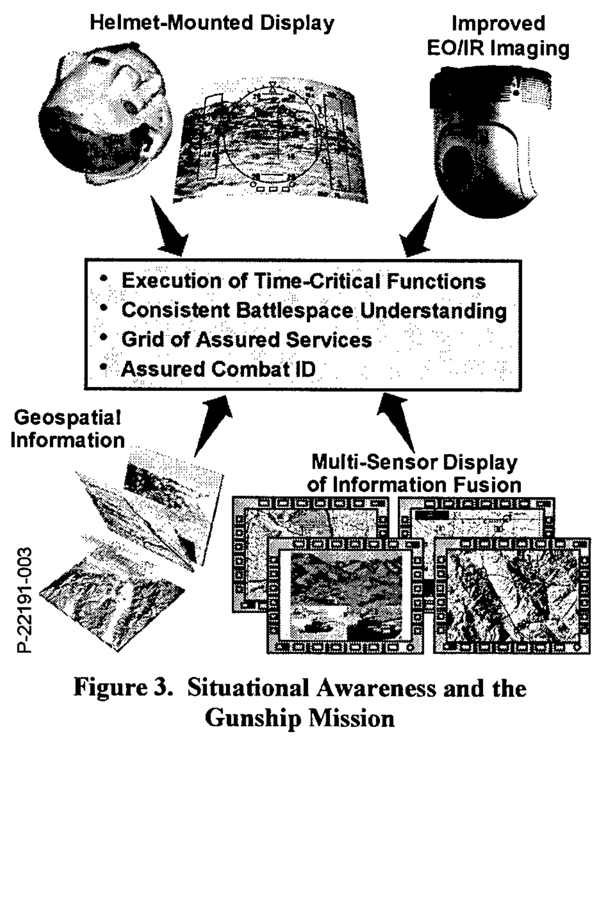


Figure 3. Situational Awareness and the Gunship Mission

In keeping with the system architecture for central mission processing, these functions are integrated within the Mission Computer, allowing video access paths to exist for future accommodation of FLIR imagery projection on the visor and capture of helmet camera video for storage and display. It is also in this setting that camera sensor processing, symbol creation, and tracker to weapons control is achieved. The basic helmet-mounted display is a binocular projected system, in which the projected CRT sources are delivered to a see-through visor without the hindrance of in-line optical combiners. This design approach allows for excellent exit pupil and eye relief, and from this is realized the ability to accommodate nuclear/ biological/chemical protection equipment. Figure 4 shows the physical configuration of the helmet with two cameras attached, with summaries of performance.

Military Operations in Urban Terrain and Enhanced Night Pilotage

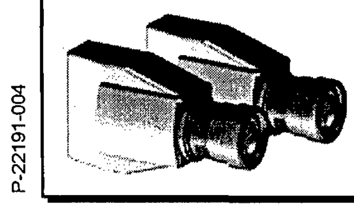
Requirements for total situational awareness reach their peak when responding to the needs of military operations in urban terrain (MOUT). It is here that maneuverability, survivability, engagement, and the support of C^4I (command, control, communication, computers, and Intelligence) interact at the highest level of conflict intensity. This demands the best human interface features, and the unequalled advantage of both crewmen looking up and out. This need emphasizes the value of a see-through helmet-mounted display with its ability to cue or steer weapons and sighting systems rapidly to targets. This demand is raised to a higher level of criticality when executed at night; yet, this is the anticipated mission role for this next generation gunship.

Until now, night pilotage has been made possible through the use of either head down thermal imaging sensors or the aviator night vision image intensified goggles. The AH-1Z requires that low light intensified imagery from the clip-on cameras be presented within the helmet and correlated with outside (see-through) information, overlayed with cueing and flight symbology. It has been necessary to develop the most advanced high resolution I^2 (image intensified) camera for this application. This design exceeds the minimal-needs with either of the redundant clip-on cameras giving projected night pilotage superior to Generation III OMNI III direct view goggles.

Additional technology has been developed in the form of low halo I^2 tubes, and anti-blooming processing to address the effects of halos from bright objects. This is always a shortcoming with night vision devices, but represents a very serious problem for military operations in urban warfare environments.

Helmet Display Performance to Requirements		
	Requirement	Provided
Field of View	40° Horiz, 30° vert	40° Horiz, 30° vert
Ambient Light Environ	To 10,000 ft-L	Sun Visor: >10,000 ft-L Clear Visor: 8,750 ft-L
Resolution and MTF	MTF>0.29 at 0.86 cy/mR	MTF=0.47 at 0.86 cy/mR
Display Viewing	Biocular or Binocular	Binocular
Head Supported Weight	4.8 lb, max.	4.74 lb (including cameras)
CG with Headform	Within Limits for Crash Safety	Within Limits for Crash Safety
Exit Pupil	15 mm (min.)	15 mm
Eye Relief	25 mm (min.)	70 mm
Interpupilary Adjustment	5th to 95th Percentile	5th to 95th Percentile
Secondary Reflection	<7% (threshold), <3% (goal)	1%
Display Update Rate	15 Frames/Sec (threshold) 30 Frames/Sec (goal)	30 Frames/Sec

Clip-On Image Intensified Cameras



- Fully Redundant Night Vision Capability
- Performance for Resolution Over Luminance Range in Access of Omni III Goggles
- Improved Intrascene and Interscene Dynamic Range
- Low Halo I² Tube with Anti-Blooming Technology

Figure 4. Performance and Mechanization Overview of the Advanced Helmet-Mounted Display System

Target Sight System

The advanced capability of the long-range target sighting system shown in Figure 5 is at the heart of stand-off weapons delivery, and is the essential sensor to complement the laser homing Hellfire Missile. Contained within a large internal volume gimballed turret assembly are three essential sensors:

1. Third generation I_nS_b midwave FLIR, with a large 8.55-inch (22 cm) aperture
2. TV system consisting of a 0.88° to 15.10° F.O.V. zoomable color camera
3. Long-life laser designator/range finder

With the gimbals internally stabilized using a fiber optics inertial sensor unit to within five μradians and with computer-based image capture and stabilization, this system provides acquisition and positive target identification displays through the full range envelope of the missile.

This true third generation FLIR provides unmatched operational performance in its support of precision guided and ballistic weapons.

Full Authority Dual Cockpits

Commonality of avionics components, including high resolution color MFDs; cyclic, collective and mission grips; backup instruments; and keyboards, are provided for both the AH-1Z and UH-1Y. Cockpit layout and human interaction are also made common to the maximum extent possible for like functions. The advantage of this to the U.S. Marine Corps includes reductions in: documentation costs, training costs, logistics costs; and the opportunity for flexible crew assignments.

Within the specific platform type, full flight and mission execution capability and authority is provided to both aircrew positions. In the gunship variant (AH-1Z), both front and rear seat positions have full control for flight, have full weapons authority, have full access to the target sighting system and of course, both front and rear aviators are equipped with helmet display subsystems.

- A true 3rd generation FLIR providing unmatched performance
- Target detection, recognition, and positive ID at and beyond maximum weapons range
- Primary sensor to support accurate delivery of precision guided and ballistic weapons

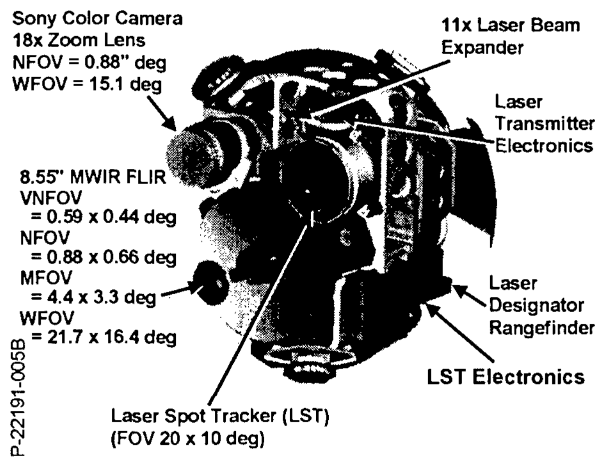


Figure 5. Long-Range Target Sighting System

This cockpit design feature positively impacts all of the overarching upgrade objectives in that it:

- Lowers acquisition cost and life-cycle cost
- Improves survivability and probability of mission success
- Enhances situational awareness
- Reduces pilot workload

This all-glass cockpit for the AH-1Z is shown in Figure 6, and features the most advanced displays adapted from commercial applications. Specifically, the color MFDs are high resolution (1024 x 768 pixels) units in an 8-inch x 6-inch (20.3 cm x 15.2 cm) viewing area, with performance under conditions of full sunlight or at night vision levels. The viewing cone exceeds ±40° vertical and approaches ±60° horizontal with excellent contrast ratios. In addition, these displays are connected to the graphics subsystems of the mission computer through high bandwidth digital interfaces so that perfect registration of pixel to graphics source is maintained in a secure electro-magnetic compatibility (EMC) installation.

Data entry displays are 4 inches x 4 inches (10 cm x 10 cm) units which also serve a dual purpose as the emergency backup instrument readout.

WEAPONS VERSATILITY AND FIRE POWER "APPLICATION OF PRECISION FORCE"

Weapon Versatility

The new AH-1Z weapons and ordnance array is the most diverse of any helicopter in the world today. Furthermore, with the full control authority given to each crewmember, engagement of separate targets can be achieved simultaneously. Figure 7 shows the AH-1Z weapons systems diversity and capacity based on the upgrade to four universal weapons stations and two wing-tip stations.

The primary antitank weapon is the AGM-114 Hellfire, which can deliver high explosive, shaped charge warhead over ranges in excess of 10 km. With target acquisition, detection and laser designation using the target sighting system, this missile uses its semi-active homing seeker either in a Lock-on Before Launch (LOBL) or Lock-on After Launch (LOAL) mode. The AGM-122 Sidearm is the second type of air-to-ground missile equipped with wideband radiation head seeker. Air-to-air engagements use the AIM-9 Sidewinder with supersonic heat seeking target closure over ranges up to 16 km.

The 20-mm turreted gun is the quick reaction weapon of choice, particularly for area suppression or close range air-to-air gunnery. This weapon can be deployed in a helmet or target-sighting system steered mode or can be set to a fixed forward firing position. Delivering 20-mm high explosive shells at approximately 630 rounds per minute, this 3-barrel Gattling gun is a formidable weapon.

Either 7 or 19 round rocket pods are available in the weapons complement. These are standard 2.75-inch (7 cm) rockets for air-to-ground use with a variety of warheads including flechettes, smoke, illumination, and high explosion antitank (HEAT).

It is the avionics system that combines these missiles, rockets, and guns into a powerful integrated suite of weapons. This is achieved by coupling the acquisition and control of the weapons to the sighting and helmet systems, and through the accuracy enhancements of computer-based fire control processing. The improvements to guns and rockets, as a result of the integrated avionics system fire control processing, are shown in Figure 8.

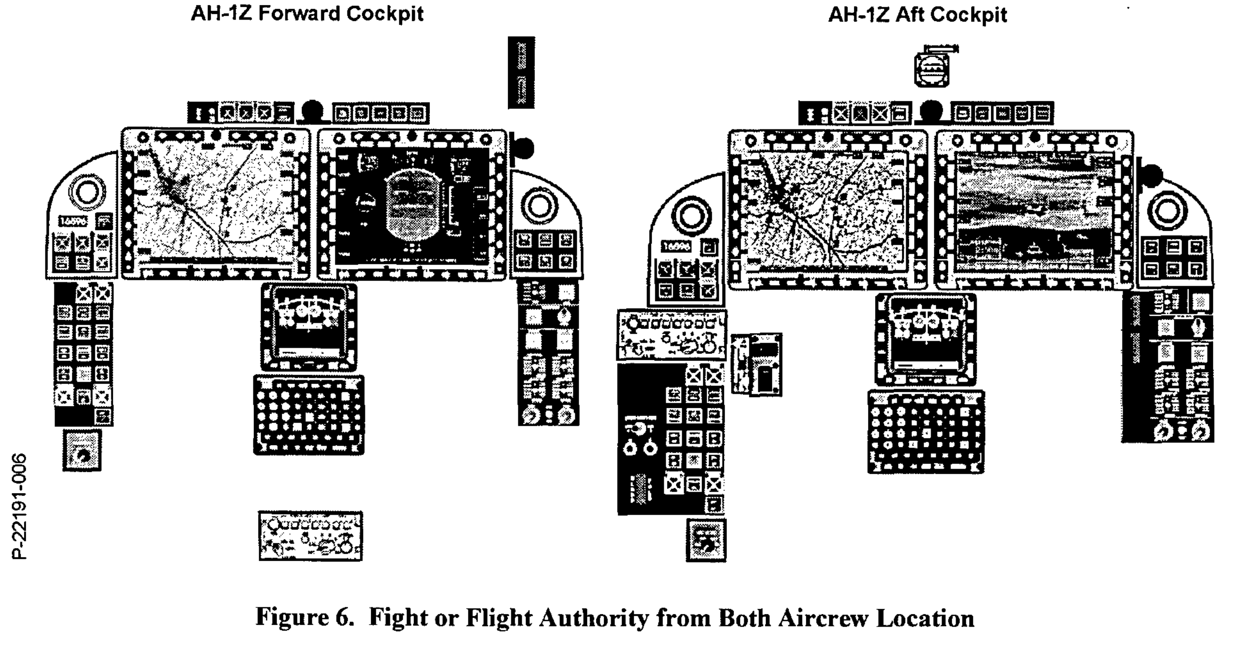


Figure 6. Fight or Flight Authority from Both Aircrew Location

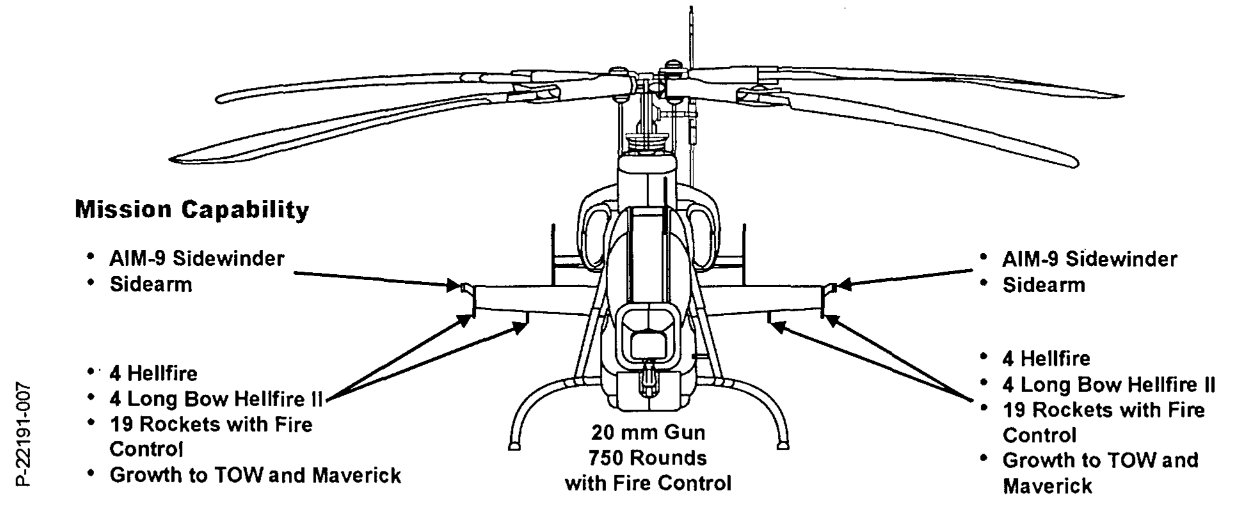


Figure 7. Widest Array of Ordnance of any Attack Helicopter

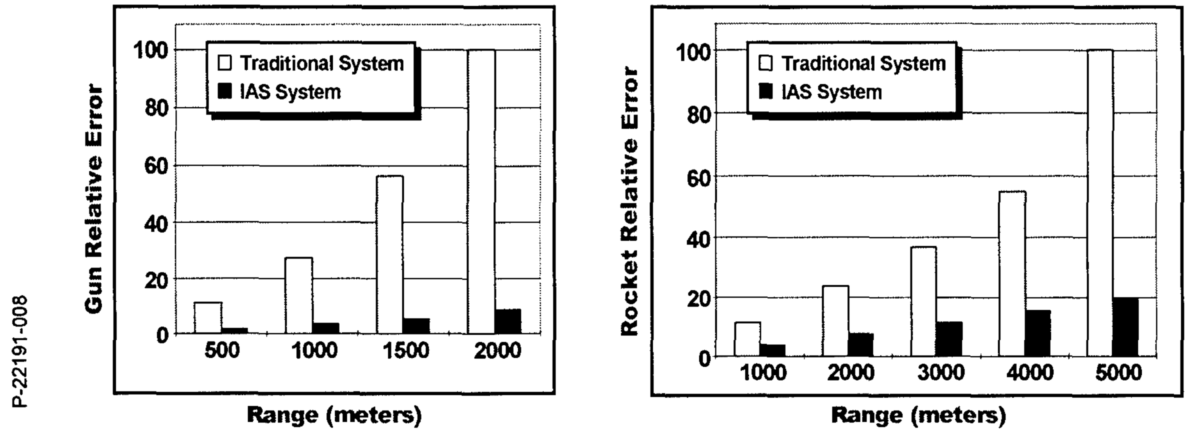


Figure 8. Relative Error Improvements with Integrated Avionics Systems

THE TOTAL INTEGRATED AVIONIC SYSTEM

Maximum commonality of product across platforms; achievement of redundancy and backups in all critical areas of processing, displays, and essential sensors; massive reserves of processing and bus bandwidths are delivered within the Integrated Avionics System. Figure 9 shows the total complement of components and architecture for the AH-1Z, in concept form. Figure 10 shows a more accurate depiction of the relative architecture of the AH-1Z and UH-1Y. It also clarifies the degree of component and architectural commonality, as well as showing the degree of redundancy provided to achieve high probabilities of mission success. Beyond those items of displays, sensors and weaponry previously discussed, are the elements which support other key functions. These include:

Communications: based upon the new U.S. Navy standard RT-1794 integrated radio, combines UHF/VHF, COMSEC, and modem into a single unit. For the UH-1Y is further added the expansion to SATCOM in support of its combat coordination and information transfer role. Both aircraft are provided new tactical data communications capability created within the centralized Mission Computer to generate, receive, and exploit digital messages and imagery in accordance with the new standards of Variable Message Format (VMF) standards.

Navigation: is primarily achieved with the U.S. Navy Embedded GPS Inertial (EGI) and air data subsystem, which in the case of the AH-1Z is a low airspeed subsystem necessary to support weapons delivery in hover or at near zero speed. Backup sensors and displays are provided in the event of a total IAS failure. A modern, U.S. Navy standard digital map system is provided supplying full capability for Digital Terrain Elevation Data (DTED) and Compressed Arc Digitized Raster Graphics (CADRG). It also is used as a navigator map display source, as a threat visibility indicator, and is part of the in-flight mission planning mode.

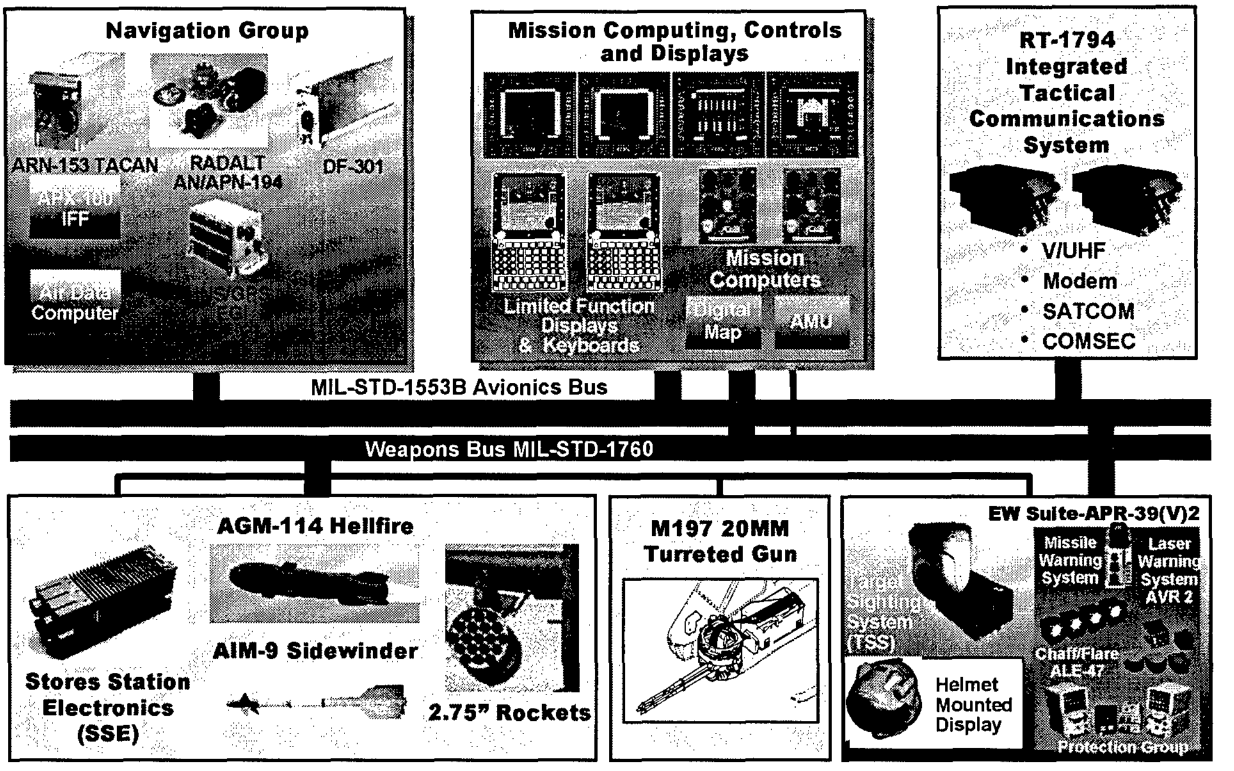


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Figure 9. AH-1Z Integrated Avionics System Components and Architecture

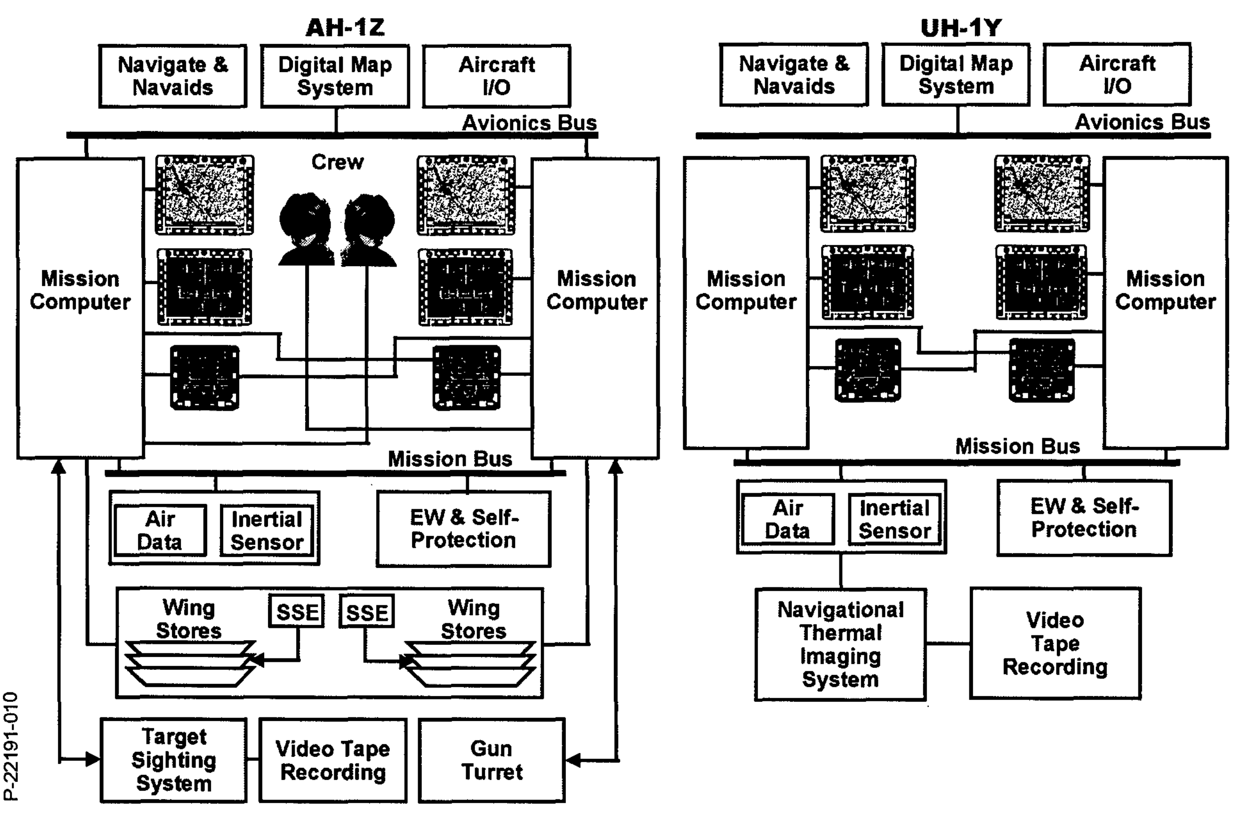

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Figure 10. Comparison of AH-1Z and UH-1Y Avionics Architecture

EW/Self-Protection: consists of Litton Applied Technology Division's (ATD) APR-39. The APR-39 is upgraded to provide full MIL-STD-1553B access of threat warning. It also displays data to the Mission Computer, thus allowing optimal integration of threat situational awareness. The ALE-47 chaff and flare dispensing subsystem is provided, together with the AAR-47 missile warning and AVR-2A laser detector.

ADVANCED OPEN ARCHITECTURE MISSION COMPUTER

Mission Computer Requirements and Design Decisions

In keeping with the overall avionics objectives for mission versatility, low cost of ownership and performance to satisfy the needs of situational awareness in a Network Centric Mission, it has been necessary to develop a new advanced Open Architecture Mission Computer incorporating the following important design points: 1) The need to deliver enormous capacity for processor throughput, memory and internal communication bandwidth, all of which is essential in accommodating the demands of information superiority. 2) This computer will be at the core of functional upgrades over the next 25 years, and must come equipped with provisioned spare capacity and be able to accept future module insertion. 3) The ability to install third party modules requires that open architecture standards for mechanical form factor and backplane electrical interfaces be included.

Interpreting these requirements into a design mechanization was undertaken by realizing that the following be included:

- Maximum exploitation of Advanced Commercial Componentry is essential to yield high functional density, and hence performance margins. This in turn interprets into the need for sophisticated thermal management.
- Selection of the ANSI VITA Standards for 6U VME mechanical form factor and backplane connection. Shortcomings found in catalog solutions have been overcome through architectural expansion, while maintaining compliance to standards.
- Designs of modular subfunctions which could build whole functions at the plug-in module level. This not only achieves lower cost of ownership and lower design cost, but also address the major VME shortcoming of interconnection bus bandwidth.

Exploitation of Commercial Componentry

Revolutionary gains in commercial electronics have occurred which makes possible advanced avionics performance. These are evident in all of the functions for mission computers with general-purpose processor throughput, memory density, graphics processing and digital video manipulation at the forefront. In each of these areas, the improvements in capability, whether measured in throughput; polygons per second; texture pixels per second or megabits per device; essentially double every 18 months. With few exceptions the component technology source for a general-purpose avionics Mission Computer is derived from the PC (personal computer) marketplace. The performance expectations in terms of processing power, graphics rendering and even power/volume are perfectly matched. For military applications these commercial solutions are essential, and lead to a challenging thermal management problem. Gone are the days when the military marketplace could specify and obtain advanced components operating from -55°C to +125°C. Today it is necessary to tailor the environment around the commercial device whose performance is likely to be in the range of -20°C to +80°C. This tailored environment still must withstand installation in aircraft and environmental exposures, which are extreme in all regards, including external temperatures from -55°C to +71°C. To add to this thermal challenge is the fact that the more advanced IC components from the commercial marketplace are packaged to dissipate heat from the top cover of the device, not the mounting base, making the traditional "Core Heat Sink" module design imperfect. This new Mission Computer uses a combination of processes and design features to solve this problem:

- Component rescreening and analysis of IC foundry techniques, which ensure that a device will operate reliably beyond its advertised commercial temperature, range.
- Selective use of high thermally conductive encapsulated composite fibers, which can be applied to high value, high power dissipating parts to conduct heat efficiently to housing side-walls.
- Selective use of Thermo-Electric devices (Peltier junction) which can be allocated to selected components or component areas, and maintain a much narrower thermal swing.

6U VME Standards and Their Shortcomings

Although the PC internal processor and backplane interconnection is built upon a set of interface standards which includes PCI bus, ISA, etc., the accepted military standard for open architecture has become 6U VME which establishes a precise module mechanical form factor, backplane connector type, and interconnection bus. Deficiencies exist in each of these areas, but it does have the value of a large product base, and a well-maintained set of standards. The advanced Mission Computer provides installation capability for all third party 6U VME modules and provides full compliance to the ANSI VITA standards with its custom fitted modules. However, architectural and mechanization features are used to overcome the deficiencies found in catalog solutions. Specifically, these include:

- 6U VME baseline connectors are limited in allocation for backplane custom use. Specifically, the two 91-pin connectors are pre-allocated to VME_{64} bus and power, leaving only 60 user definable pins and is inadequate for efficient module partitioning. The Standards Committee has addressed this with extensions to an additional P-0 connector, and increases to a 4th and 5th row on the basic P-1 and P-2 connectors. This Mission Computer fully exploits this expansion.

- The basic 6U VME module is mechanically designed as a single sided heat sinked module and has two serious deficiencies: 1) with modern low profile components it is possible to create double-sided modules and double the capacity of function, and 2) that advanced commercial ICs need heat sinking from the top (not the base as is the case in the standard module). Most catalog solution address this by the installation of plug-on mezzanines, but their mechanical integrity is suspect in military environments, or the complexity of attachment structure diminishes the packaging footprint. This mission computer design uses a central core heat-sink, which accepts a two-sided PCB fitting, and adds custom top-heat-sink attachments for selective parts. All of this is accomplished in the standard width of 0.8 inch (2 cm), and is substantially more rugged and far more thermally efficient.
- Backplane bus bandwidth, more than any other aspect of the Mission Computer, provides for functional upgrade or limits its growth. In this regard, the 6U VME standard, even with the expansion to VME_{64}, is at the low end of capability. For this Mission Computer, the VME bus has been allocated only the task of global control and low bandwidth functional interconnect. No attempt is made to use this bus for such functions as Graphics Display List Management, Memory Access, or transfer of realtime digital data bases. In order to deliver both the functional interconnection bandwidth for the current avionics and to have convenient upgrade approach, the design strives to put "whole functions" on single plug-in modules so that the high bandwidth PCI bus can be linked without exiting into the backplane. In selective zones, the backplane is enhanced by careful addition of interconnection links using PCI bus, LVDS internal digital video and fiber channel external digital video.

This tailoring of backplane using "drop-on" flex-prints is part of an interconnection scheme that consists of a multi-layer PCB in which the 6U VME standard interconnect is equipped in copper etch, critical "tailored" buses use. "Drop-on" flex-prints and low bandwidth noncritical signals can be made with wire-wrap. In this way all of the flexibility for growth is given while compliance to standards is maintained.

Mixing and Matching With Modular Subfunctions

A careful partitioning of modular functions and subfunctions has been achieved which supports the need for bandwidth maintenance, thermal allocation and maximum reuse. Specifically a number of basic building blocks of high performance functions are designed which can be mixed by allocating to module sides (A-Side/B-Side). These include general purpose "standard host processor", graphics processor, input video multiplexer/digital converter, input/out functions, etc. This approach to backplane interconnects and subfunction tailoring is shown in Figure 11.

AH-1Z AND UH-1Y MISSION COMPUTER FEATURES

These principles of design have been applied to the AH-1Z and UH-1Y Mission Computers, realizing all of the global objectives for delivery of substantial performance, growth and upgrade flexibility and accommodation of third party modules through compliance to Open Architecture Standards. Figure 12 shows the module complement for AH-1Z Mission Computer, and the logical subset for UH-1Y. It shows that in a 14-module slot housing, 6 growth slots remain for AH-1Z and 11 growth slots for UH-1Y. Figure 12 also shows the two third-party supplier-provided 6U VME modules for the helmet subsystem. Most notably is shown the manner in which functional building blocks have been mixed to tailor whole functions at the module level. In the case of the AH-1Z the powerful "Standard Host Processor" has been used as an "A-Side" fitted subfunction to support four separate whole functions as Mission Processor, Graphics Processor, Weapons Processor, and VTR Symbology Processor.

A standard housing, air plenum/mount and power-supply is used for both AH-1Z and the depopulated UH-1Y. The enclosure, together with the internal module design features, provides a fully compliant solution to the need of MIL-STD-810C environment and to the electro-magnetic compatibility needs of MIL-STD-461/462. This is shown in Figure 13.

The equipped Mission Computer performance is summarized in Table 1. Major points to be noted:

- Delivery of 800 MIPs of processor throughput in AH-1Z
- 256 MB of main memory
- 8 equipped 1553B buses

Also a video and graphics subsystem is included, in which a single module can drive two simultaneous high resolution color screens, with realtime scene-generated graphics and video overlay/windowing. Against this fitted capability the baseline solution uses less than 20 percent of the throughput, less than 30 percent of the memory, and only 3 of the 8 fitted MIL-STD-1553B channels.

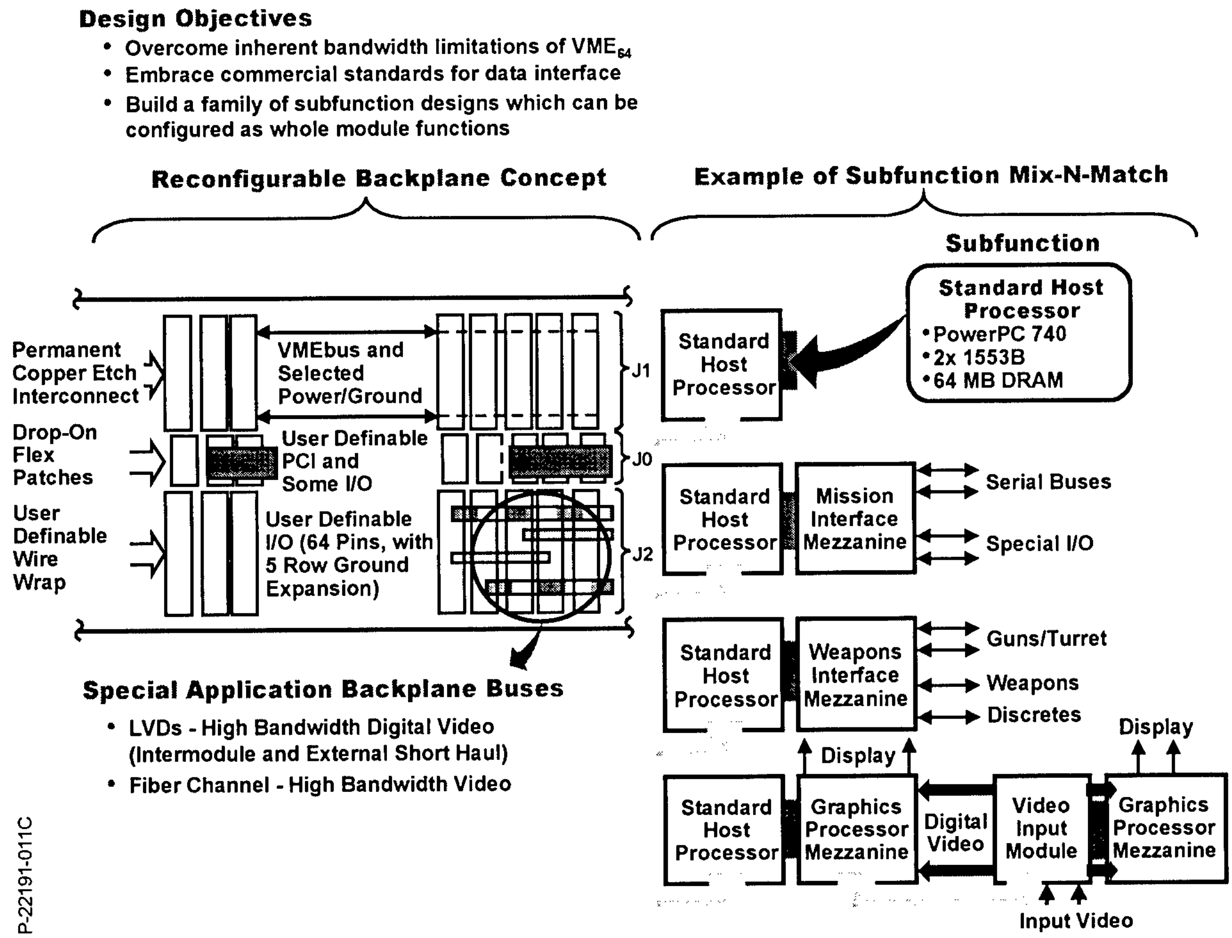

Figure 11. Mission Computer Concepts of Backplane Interconnection and Subfunction Mixing

CONCLUSION

The H-1 IAS upgrade delivers the most modern and cost-effective suite of avionics available today, and addresses the mission needs of the next quarter century with full appreciation for growth and change. This adds to the benefits achieved in other areas of platform upgrade, providing to the U.S. Marine Corps essentially, a new fleet of helicopters for versatile Attack and Utility missions.

Side A	Side B		Module Content: AH-1Z Computer	Module Content: UH-1Y Computer
Standard Host Processor • PC603 (740) • PCI Bridge • 2 x 1553B • 512K Flash • 64 MB DRAM • 32K NOVRAM	**Mission Interface Mezzanine** • 7 x ARINC 429 (3 x Receiver/4 x Trans) • 2 x RS-422 • Force Stick I/O • VME Slave • 9 Discretes • 4 Output Discretes	= Mission Processor Module	1	1
Standard Host Processor • PC603 (740) • PCI Bridge • 2 x 1553B • 512K Flash • 64 MB DRAM • 32K NOVRAM	**Graphics Processor Mezzanine** • 3D Lab 500 MX/Gamma • 2 x Fiber Channel Graphics Outputs (1024x768) • 2 Output Frame Buffers	= Graphics Processor Module	1	1
Video Capture Processor • 12 Reconfigurable Composite Video Inputs • Zoom; De-interface; Capture	**Graphics Processor Mezzanine** • 3D Lab 500 MX/Gamma • 2 x Fiber Channel Graphics Outputs (1024x768) • 2 Output Frame Buffers	= Video Processor Module	1	1
Standard Host Processor • PC603 (740) • PCI Bridge • 2 x 1553B • 512K Flash • 64 MB DRAM • 32K NOVRAM	**Weapons Interface Mezzanine** • Full Digital Gun Loop • I/O to SSE • 28 Input Discretes • 24 Output Discretes	= Weapons Processor Module	1	N/A
Standard Host Processor • PC603 (740) • PCI Bridge • 2 x 1553B • 512K Flash • 64 MB DRAM • 32K NOVRAM	**Helmet Processor Mezzanine** • Adapted Form Graphics Processor Mezzanine • LVDS Graphics Output • RS-170 Graphics Output	= VTR Symbology Module	1	N/A
HMD Interface • Calculate Distortion Correction • Drivers/Creates CRT Ramps • 2 Channels/Module	**Camera Electronics Mezzanine** • Capture and Processes Camera Video • 2 Channels per Module	= HMD Processor Module	1	N/A
Helmet Tracking Module	Supplier Provided 6U VME Module	= Helmet Tracking Module	1	N/A
Helmet Deflection Module	Supplier Provided 6U VME Module	= Helmet Deflection Module	1	N/A
		Available Spare Slots	6	11

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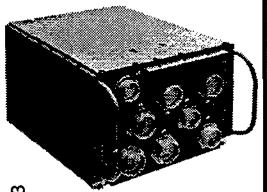
Figure 12. AH-1/UH-1 Module Combinations

Mission Computer



P-22191-013

Characteristic	AH-1Z	UH-1N
Size	15.47 in. (L) x 11.5 in. (W) x 8 in. (H)	15.47 in. (L) x 11.5 in. (W) x 8 in. (H)
Weight	35.5 lb	24.5 lb
Power (28V) (AC)	313 watts 80 watts	110 watts 80 watts
Reliability	1303 hr MTBF	3693 hr MTBF
Maintainability	99% BIT Detection 98% Isolation to WRA	99% BIT Detection 98% Isolation to WRA

- Environmental Qualification Tests to MIL-STD-810E
  - Temperature/Altitude
  - Humidity
  - Fungus
  - Salt Fog
  - Sand and Dust
  - Explosive Test
  - Vibration
  - Shock
- EMC Testing to MIL-STD-462

Figure 13. Comparison of AH-1Z and UH-1Y Mission Computers

Table 1. Mission Computer Performance Summary

		AH-1Z	UH-1Y
Physical			
Housing Characteristics		Full ATR/15.5" Long	Full ATR/15.5" Long
Module Format		6U VME (+Connector Ext)	6U VME (+Connector Ext)
Cooling (Housing Level)		Fan Forced Air	Fan Forced Air
Cooling (Module)		Conduction	Conduction
Backplane Interconnect		Copper Etch + Custom Zones	Copper Etch + Custom Zones
Front Panel Attachment		Re-configurable Flex + Filters	Re-configurable Flex + Filters
Total 5 Lots (Provisioned/Used)		14/8 (6 Spare)	14/8 (11 Spare)
Functional			
General Purpose Processing (Standard Host Processor)	Frequency/Throughput	4 x (200 MHz/200 MIPS) = 800 MIPS	2 x (200 MHz/200 MIPS) = 400 MIPS
	Main Memory	4 x [64 MB (128M Avail)] = 256 MB	2 x [64 MB (128M Avail)] = 128 MB
	Boot/NOVRAM	4 x [512 KB/32 KB] = 2048 KB/128 KB	2 x [512 KB/32 KB] = 1024 KB/128 KB
	PCI Bridge	Equipped Each Module	Equipped Each Module
Video Graphics Subsystem (Graphics Processor/ Video Capture)	Graphics Outputs (Digital)	4 x [1024 x 768 Full Color] Reconfigurable	4 x [1024 x 768 Full Color] Reconfigurable
	Input Video	12 Reconfigurable Channels	12 Reconfigurable Channels
	Video/Graphics	Zoom; De-Interlace; Window in Window Overlay	
	Graphics Features	Anti-Alias; Alpha Blend; Polygons & Textures; Freeze Frame	
Weapons Subsystem	Guns (20 mm)	Full Digital Gun Control Loop	N/A
	Missiles/Rockets	Control of SSE (Software)	N/A
General Input/Output	1553B	8 Equipped (3 Assigned)	4 Equipped (3 Assigned)
	ARINC 429	3 Receivers/4 Transmitters	3 Receivers/4 Transmitters
	RS-422/RS-237	4 x 4 RS-422	2 x 4 RS-422
	Discretes In/Out	47 x Inputs/28 x Outputs	19 x Inputs/4 x Outputs
	Other Serial	Fiber Channel/Ethernet	Fiber Channel/Ethernet
	Graphics Creation	All HMD Symbology	N/A
Helmet Display Subsystem	CRT Drive	Deflection & Distortion Correction	N/A
	Night Pilotage Cameras	Camera Processing/Overlay	N/A
	Head Track On	Processing & Calibration	N/A